B421

AUTOBALANCE COMPONENT BRIDGE

OPERATING INSTRUCTIONS

WAYNE KERR

OPERATING INSTRUCTIONS

for

AUTOBALANCE COMPONENT BRIDGE B421

THE WAYNE KERR COMPANY LIMITED

ROEBUCK ROAD CHESSINGTON SURREY ENGLAND

CONTENTS

INTRODUCTION	5
SPECIFICATION	7
OPERATING INSTRUCTIONS	10
Switching on	10
Inductance Measurements	10
Capacitance Measurements	11
Resistance Measurements	13
Electrolytic Capacitance & Leakage Current Measurements	14
The Comparator	14
MEASUREMENT CONDITIONS	15

The Reference Number of this Publication is TP21/2

WAYNE KERR
Autobalance Component Bridge
B421
Calibrate
Zero (C+)
FSD (L.C.R)
Docade
C&R Only
OUT
Facility
OFF
Range
1
2
3
4
5
6
7
Standard

INTRODUCTION

The Autobalance Component Bridge B421 is a direct-reading instrument for the rapid determination of resistance, capacitance and inductance values. A comparator facility allows a resistive or capacitive component to be compared with an external standard, a separate meter scale, calibrated from −25% through zero to +25%, being provided for the purpose.

The instrument is transistorized, uses printed circuit techniques and operates on the transformer ratio arm principle. Since the bridge is self-balancing, both for in-phase and quadrature components, its use is very simple, the controls being limited to those necessary for initial calibration, range and facility selection and a single decade control. The latter operates on the C and R ranges only and is used when the required accuracy is greater than that given by the basic meter indication. The pressing of a button converts the meter indication to series resistance of inductors or parallel resistance of capacitors as the case may be. The marking of both the meter scale and the range switch is simplified by the inclusion of a colour-coded plate on the front panel. This plate shows in tabulated form the meter multiplication factor for each range and facility. A separate table gives the coverage of the comparator bridge ranges.

A feature of the B421 is its ability to measure high value electrolytic capacitors and their leakage currents. Normal bridge principles are not suitable for measuring these components and, moreover, since their tolerance is usually about −10% to + 100% of nominal value, a measuring accuracy of one-quarter percent is meaningless. The B421 therefore has a special circuit for measuring capacitance values above 10μF.

Screened connectors are provided for the two coaxial measurement leads, each terminated in a single crocodile clip. These provide the two connections to the component under test. The instrument is 'splash-proof' and meets full Government climatic and durability requirements which, in conjunction with its portability, makes it eminently suitable for use in the field. If desired, power supply PS109/2 can be removed and the instrument can then be connected to an external battery supply.

SPECIFICATION

Measurement Ranges

Range	Resistance R	Inductance L	Series Res. R_s	Capacitance C	Parallel Res. R_p†
1	0—10Ω	0—100μH	0—1Ω	0—10μF	100Ω—∞
2	0—100Ω	0—1mH	0—10Ω	0—1μF	1kΩ—∞
3	0—1kΩ	0—10mH	0—100Ω	0—100nF	10kΩ—∞
4	0—10kΩ	0—100mH	0—1kΩ	0—10nF	100kΩ—∞
5	0—100kΩ	0—1H	0—10kΩ	0—1nF	1MΩ—∞
6	0—1MΩ	0—10H	0—100kΩ	0—100pF	10MΩ—∞
7	0—10MΩ	0—100H	0—1MΩ	0—10pF	100MΩ—∞
Accuracy	±0.25% of Range max.	±2% f.s.d.	±2% f.s.d.	±0.25% of Range max.‡	±2% of Range min.
Indication	Decade Dial and Meter	Meter only	Meter only	Decade Dial and Meter	Meter only
Discrimination	0.1% of Range max.	1% f.s.d.	1% f.s.d.	0.1% of Range max.†	—
Smallest Indication	20mΩ ‡	2μH *	20mΩ *	0.02pF ‡	100Ω ‡

* If it is required to measure inductance in which the series resistance is very great, the smallest indication can be regarded as 2μH per ohm f.s.d. Conversely, if it is required to measure resistance in the presence of swamping inductance, the smallest indication can be regarded as 200Ω per Henry f.s.d. This is equivalent to a Q of approximately 30.

† The resistance (R_p) ranges quoted in the table above apply when the decade dial is in use. When the decade dial is set to OUT the resistance range is decreased by a factor of 10. Thus, for example, on Range 7 with the decade OUT the meter indicates 0—10pF and the corresponding parallel resistance range is 10MΩ-∞. The capacitance accuracy with the decade OUT drops to 2% f.s.d. and the discrimination to 1% f.s.d.

‡ With Decade switch in circuit.

High Capacitance (Ce)

Range	Scale Range	Applied Voltage	Leakage Current**
1	—	—	0—10mA
2	—	—	0—1mA
3	—	—	0—100μA
4	10μF—∞	20/C volts*	—
5	100μF—∞	200/C volts*	—
6	1000μF—∞	2000/C volts*	—

* C is the value of the measured capacitance (μF).
** Measured with 3V applied. Leakage current is independent of capacitance value.

Indication by meter only on green reciprocal scale.
Largest indicated value: 50,000μF.
Accuracy: (4 + A) % where A is the scale indication.

Comparator

Range of comparison: ±25% indicated on blue centre-zero scale of meter.
Accuracy: ±1 scale division
Discrimination: 0·5 scale division

Comparator Range Coverage

Range A: 5Ω to 200kΩ, 1nF to 10μF
Range B: 50kΩ to 10MΩ, 10pF to 4nF

Bridge Frequency 1000Hz ±2%

Operating Temperature 0—55°C

At the extremes of the working temperature range, the accuracy of the instrument deteriorates by a maximum factor of two (three on electrolytic [Ce] measurements).

Temperature Coefficient of Standards

R: 20 p.p.m. per deg. C
C: 15 p.p.m. per deg. C

Power Supply

The instrument is normally supplied fitted with Power Supply type PS109/2 for operation from 100—125V or 200—250V, 50—60Hz. However, this unit can be withdrawn, thus exposing a pair of leads which can be connected to an external 9V dry battery (e.g. two Ever Ready type 126 batteries) if it is required to operate the instrument in the absence of a power supply.

Current drain: approximately 30mA on R and L
25mA on other facilities

Dimensions		
	Height:	230 mm. (9 in.)
	Width:	280 mm. (11 in.)
	Depth:	178 mm. (7 in.)
	Weight:	5.5 kg. (12 lb.) approx.

Ancillary Equipment Supplied

Two pairs of connectors terminated at one end with BNC connectors and at the other end with crocodile clips.

OPERATING INSTRUCTIONS

SWITCHING ON

The instrument is supplied with a three wire connecting lead for the a.c. supply, terminated with a three pin free socket at one end. This should be inserted into the input plug at the rear of the instrument. The free end of the lead should be fitted with a suitable three pin plug. Connect red (or brown) to live, black (or blue) to neutral and green (or green striped yellow) to ground. (Two colour codes are in use.)

When the instrument is powered with dry batteries, set the Facility switch to the check battery position (marked —| |—) and note that the meter indication is above the MIN. BAT. VOLTS line. If this is not the case, renew the batteries. This check is not necessary when power supply unit PS109/2 is fitted except as a power check in the event of non-operation of the instrument. The power transformer connections are as follows:

200—250V operation terminals 2 and 3 linked

100—125V operation terminals 1 and 2, 3 and 4 linked

Note that the power supply unit is controlled by its own On/Off switch on the rear of the instrument.

If the L, C or R facility is to be used, set the Facility switch to the appropriate position and the Calibrate switch to F.S.D. (L.C.R.). Adjust the right-hand calibrate control until the meter indicates 10.

If the Ce facility is to be used, set the Facility switch to Ce, the Range switch to 4, 5 or 6 and the Calibrate switch to Zero (Ce). Adjust the left-hand calibrate control until the meter indicates ∞ on the green reciprocal scale.

Set the Calibrate switch to Operate.

INDUCTANCE MEASUREMENTS

Connect the component under test directly to the Unknown sockets. Set the Facility switch to L and the Range switch to 7. Decrease the measurement range until a meter indication between 1 and 10 is obtained on the black scale. From the table beneath the meter, note the multiplication factor for the appropriate range and apply this to the meter indication to obtain the value of the unknown inductance.

The series resistance of the inductor under test is obtained by pressing the white button situated to the left of the range numbers beneath the meter.

The appropriate multiplication factor from the table must be applied to the meter indication (black scale) to obtain the value of the series resistance.

Example: The meter indicates 2.5 when Range 4 is selected. The L multiplication factor for Range 4 is 10mH and so the inductance of the component under test is 25mH. On pressing the white button, the meter indicates 1.4. The R_s multiplication factor for Range 4 is 100Ω and so the series resistance is 140Ω.

NOTE: 1. If the meter deflection is off the scale when the white button is pressed (i.e. the Q is less than unity at 1kHz) turn the Range control to the next higher range and check the inductance value on this range before measuring the series resistance. This is necessary because the inductance measurement is valid only if the series resistance indication is on scale for the range in use. FOR THIS REASON R_s SHOULD ALWAYS BE MEASURED WHETHER THE INFORMATION IS REQUIRED OR NOT.

2. The total inductance of a pair of measurement leads Type BML7, together with the internal circuit, is approximately 4μH. For greatest accuracy this should be subtracted from any inductance values obtained on Range 1. If other leads are used the correction figure can be obtained by connecting the ends of the leads together and noting the inductance value on Range 1.

CAPACITANCE MEASUREMENTS

To calibrate the instrument, select F.S.D. (L.C.R.) and adjust the right-hand calibrate control until the meter indicates 10, then return the switch to Operate.

Connect the component under test directly to the Unknown sockets. Set the Facility switch to C, and Decade switch to OUT and the Range switch to 1. Increase the measurement range until a meter indication between 1 and 10 is obtained on the black scale. From the table beneath the meter, note the multiplication factor for the appropriate range and apply this to the meter indication to obtain the value of the unknown capacitor.

The value thus obtained is accurate to within ±2%. For greater accuracy, transfer the first digit of the meter indication to the Decade switch; the meter indication is then the second and subsequent significant figures of the required value.

The parallel resistance of the capacitor under test is obtained by pressing the white button to the left of the range numbers beneath the meter. Note the meter indication on the GREEN reciprocal scale and apply the appropriate multiplication factor from the table to obtain the value of the parallel resistance. Note that the multiplication factor as read from the table applies only when the Decade switch is in use. When the Decade switch is set to OUT, the multiplication factor for R_p must be divided by 10. Thus the parallel resistance of capacitors having a poor power factor can be measured with the Decade out.

Example: The meter indicates 4.6 when Range 5 is selected. The C multiplication factor for Range 5 is 100pF and so the capacitance of the component under test is 460pF. If, when the Decade switch is set to 4, the meter indicates 6.8 the correct value of the capacitor is 468pF. In this condition, on pressing the white button, the meter indicates 2.5 on the green reciprocal scale. The R_p multiplication factor for Range 5 is 1MΩ i.e., 1 on the green scale is equivalent to 1MΩ and so the parallel resistance of the capacitor is 2.5MΩ. Had the white button been pressed before the operation of the Decade switch, the meter indication would have been approximately 25; the R_p multiplication factor then being one-tenth that shown in the table (i.e. 100kΩ) gives a parallel resistance of 2.5MΩ as before.

NOTE: 1. As with inductance measurements, the capacitance indication is valid only if the associated parallel resistance measurement is 'on scale'. If the meter deflection is off scale (i.e. less than 1 on the green scale) when the white button is pressed, move the Range switch to the next lower number and repeat the capacitance measurement.

2. To obtain the stated accuracy on Ranges 6 and 7, special Low Capacity

Measuring Leads (Type LCC3) should be used. These leads have a third connection coloured green, which should be left disconnected.

3. It is recommended that, when measuring a number of capacitors, the Calibrate switch is set to F.S.D. (L.C.R.) between each measurement to avoid possible overloading of the meter.

RESISTANCE MEASUREMENTS

To calibrate the instrument select F.S.D. (L.C.R.) and adjust the right-hand calibrate control until the meter indicates 10, then return the switch to Operate. The B421 is not intended to measure resistors whose reactive angle is greater than 10° (i.e. $\frac{\omega L}{R}$ or $\omega CR < 0{\cdot}17$).

Connect the component under test directly to the Unknown sockets. Set the Facility switch to R, the Decade switch to OUT and the Range switch to 7. Decrease the measurement range until a meter indication between 1 and 10 is obtained on the black scale. From the table beneath the meter, note the multiplication factor for the appropriate range and apply this to the meter indication to obtain the value of the Unknown resistance. The value thus obtained is accurate to within $\pm 2\%$. For greater accuracy, transfer the first digit of the meter indication to the Decade switch; the meter indication is then the second and subsequent significant figures of the required value.

Example: The meter indicates 4 when the Range switch is set to Range 3. The R multiplication factor for Range 3 is x100Ω and so the value of the resistor is 400Ω. If, when the Decade switch is set to 4, the meter indication falls to —0.2 (in the red sector to the left of the black scale) the correct value of the resistor is 398Ω. This can be verified by resetting the Decade switch to 3; the meter indication should rise to 9.8.

NOTE: The total resistance of a pair of measurement leads Type BML7, together with the internal circuits, is approximately 200mΩ (0.2Ω). For greatest accuracy, this should be subtracted from any resistance values obtained on Ranges 1 or 2. If other leads are used, the correction figure can be obtained by connecting the ends of the leads together and noting the resistance value on Range 1 (using the Decade as described above).

ELECTROLYTIC CAPACITANCE AND LEAKAGE CURRENT MEASUREMENTS

When the Ce facility is to be used, set the Facility switch to Ce, the Range switch to 4, 5 or 6 and the Calibrate switch to Zero (Ce). Adjust the left-hand Calibrate control until the meter indicates ∞ on the green reciprocal scale.

Set the Calibrate switch to Operate.

Connect the component under test to the Unknown sockets, positive of the capacitor to the E socket.

Press the black button at the lower right-hand corner of the table on the front panel and check that the meter indicates ∞ on the green scale. Release the button. When the meter has slowly deflected and come to rest, note the meter indication on the green scale (this should not go beyond 1, or go beyond the final rest position and then return, on the range chosen, because this indicates an overload condition). If the meter indication is between 10 and ∞, select Range 5 and repeat the foregoing operation; if the indication is still between 10 and ∞, select Range 6 and again repeat the operation. Note the final meter indication and apply the appropriate multiplication factor from the table beneath the meter to obtain the value of the capacitor under test.

To measure the leakage current, set the Range switch to 1 and allow a few seconds for the capacitor to charge. Press the black push button and note the meter indication on the black scale. If the indication is less than 1, change the Range switch setting to 2 or 3, as necessary, while holding the black button pressed. Apply the appropriate multiplication factor to the meter indication to obtain the value of the leakage current for the capacitor under test.

NOTE: It is recommended that when measuring a number of electrolytic capacitors, the Calibrate switch is set to Zero (Ce) between each measurement to avoid possible overloading of the meter.

THE COMPARATOR

Calibrate the instrument in the F.S.D. (L.C.R.) switch position in the normal manner.

If the components to be compared are resistive, the reference component should be connected to the Standard sockets; if the components are capacitive, the reference component should be connected to the Unknown sockets.

From a knowledge of the nominal value of the components, select Range A or B as appropriate.

The meter then indicates on the blue scale the percentage difference between the values of the components.

An indication of $+x\%$ means that the value of the test component exceeds the value of the reference component by $x\%$.

MEASUREMENT CONDITIONS

This section gives the voltage applied to the Unknown during measurement. Because both the configuration of the bridge and the gain of the error amplifier are changed when switching to the various facilities, the voltage applied to the Unknown varies according to the facility selected, the decade setting and the meter indication.

Capacitance

For these measurements, the applied voltage depends only on the setting of the Range switch.

Range	Applied Voltage
1 & 2	23.5mVr.m.s.
3 & 4	235mVr.m.s.
5 & 6	2.35Vr.m.s.
7	23.5Vr.m.s.

Inductance

For these measurements, the applied voltage is a function both of the range in use and of the meter indication.

Range	Applied r.m.s. Voltage when Meter indicates 1 on black scale	
1 & 2	150μV	For other values, multiply the voltage appropriate to the range in use by the meter indication.
3 & 4	1.5mV	
5 & 6	15mV	
7	150mV	

Example: The meter (black scale) indicates 6 on Range 5.

L=600mH Applied voltage=6 × 15=90mV.

Resistance

For these measurements the applied voltage is a function of the Range setting, the meter indication and the Decade setting. The voltage indicated in the table below is the voltage (V) applied to the Unknown for a meter indication of 1 on the black scale when the Decade is set to out.

Range	Applied Voltage
1 & 2	230μVr.m.s.
3 & 4	2.3mVr.m.s.
5 & 6	23mVr.m.s.
7	230mVr.m.s.

With the Decade set to OUT, the applied voltage to the component under test for meter readings other than 1 will be: V=v × meter indication.

With the Decade in use, the applied voltage will be V=(10v × Decade setting) + (v × meter indication).

www.manualsplus.com
1003906

THE WAYNE KERR COMPANY LIMITED

WAYNE KERR, ROEBUCK ROAD, CHESSINGTON, SURREY, ENGLAND
Telephone: 01-397 1131 Telex: 262333 Cables: Waynkerr, Chessington

Printed in England JP/10.70/500